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APPLICATION

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for

METHOD AND APPARATUS FOR EXTRUSION COATING MULTIPLE WEBS

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METHOD AND APPARATUS FOR EXTRUSION COATING MULTIPLE WEBS

This application is a continuation-in-part of Application Serial No. 09/978,392, filed on October 16, 2001, the disclosure of which is incorporated herein by reference.

Field of the Invention

The invention relates to a method for making webs and, in particular, to a new method and apparatus for extrusion coating multiple webs simultaneously on a dual or tandem extruder system having multiple extruder stations.

Background of the Invention

Webs such as paper and paperboard, polymer films, and metal foils which have been extrusion coated with a layer of polymer film are used in a myriad of applications such as packaging materials and so forth. In some instances, it is desirable to apply two extrusion coatings to a substrate web so that both sides of the substrate are coated with an extruded polymer film. For these cases, so called "tandem" or dual extruders have been developed with multiple extrusion stations.

However, cases requiring a coating on both sides of a web by means of a dual extruder may not be plentiful enough to maintain a tandem extruder at full capacity. In these instances, it has been common practice to simply shut down one of the extruder stations and operate the dual extruder in the same manner as a single station extruder. While this prevents the extruder from remaining completely idle, it still represents a significant waste of capital resources.

It is therefore an object of the invention to provide a method for achieving more efficient and economical utilization of a dual or multiple station extruder.

Another object of the invention is to provide a method for producing extrusion-coated substrates at a higher production rate.

A further object of the invention is to provide an improved design for a web coating system.

Still another object of the invention is to provide a method for production of extrusion-coated webs on a more economical basis.

Summary of the Invention

With regard to the foregoing and other objects and advantages, the present invention provides a method for extrusion coating multiple webs in an extruder system containing multiple extrusion stations. In one embodiment, the method includes feeding a first web and a second web into a first extrusion station in the extruder system, where each web has a coating side and an underside. The webs are arranged one with respect to the other to form a temporary composite wherein respective undersides of the webs face each other and their respective coating sides face outwardly, away from each other. A first polymer coating is extruded on the coating side of the first web at the first extrusion station. The composite is fed to a second extrusion station following extrusion of the first polymer coating thereon. At the second extrusion station, a second polymer coating is extruded on the coating side of the second web of the composite. The extrusion coated first and second webs are then separated.

According to another aspect of the invention, a method is provided for extrusion coating multiple webs in an extruder system containing multiple extrusion stations which includes feeding a first web and a second web into the extruder system, each web having a coating side, conveying the first web to a first extrusion station in the extruder system and extruding a first polymer coating on the coating side of the first web at the first extrusion station and conveying the second web to a second extrusion station in the extruder system and extruding a second polymer coating on the coating side of the second web at the second extrusion station.

In still another aspect, the present invention provides a method for coating multiple webs in an extruder system containing multiple coating stations. The method includes conveying a first web having a coating side to a first coating station in the coating system from a first unwind stand and applying a first polymer coating on the coating side of the first web at the first coating station. The coated first web is collected on a first windup stand. The method also includes conveying a second web also having a coating side to a second coating station in the coating system from a second unwind stand and applying a second polymer coating on the coating side of the second web at the second coating station. The coated second web is collected on a second windup stand. According to this aspect of the method, the conveying and coating steps in regard to the first web are

carried out independently of the conveying and coating steps in regard to the second web and during at least a portion of the time in which the conveying and coating steps are being carried out in regard to the second web.

In certain embodiments of the method, it is preferred that the first web be redirected from a first web travel path to adjacent a second web travel path prior to collection on a windup stand. Preferably the first web is redirected by a web turning station such as by a plurality of web turning bars. In other embodiments of the method, it is preferred that the second web be initially conveyed from the unwind stand along a first web travel path and be redirected adjacent a second web travel path prior to being coated at the second coating station. Preferably the second web is redirected by a web turning station such as by directing the second web through a plurality of web turning bars.

It is also preferred in certain embodiments that the first and second webs comprise the same or similar materials. However, in other embodiments it is preferred that the first and second webs comprise substantially different materials. Preferred materials for the first and second webs include paper webs, polymer films, nonwoven fabrics, metal foils, or two or more thereof as a multi-ply web. The first and second webs preferably each have a basis weight of from about 7 lbs/3000 ft^2 to about 250 lbs/3000 ft^2, and preferably have a caliper of from about 0.5 mils to about 20 mils.

In certain embodiments it may also be preferred that the first and second webs be extrusion coated with the same type of polymer. However in certain other embodiments, it may be preferred that the first and second webs are extrusion coated with different types of polymers. Preferably, the first and second polymer coatings comprise a polymer selected from the group consisting of low density polyethylene (LDPE), polyolefin plastomers (POP), polyolefin elastomers (POE), linear low density polyethylene (LLDPE), high density polyethylene (HDPE), polypropylene (PP), ethylene methyl acrylate copolymer (EMA), ethylene butyl acrylate copolymer (EnBA), ethylene vinyl acetate copolymer (EVA), ethylene acrylic acid copolymer (EAA), ethylene methyl acrylic acid copolymer (EMAA), ionomoers such as SURLYN, ethylene vinyl alcohol (EVOH), polyesters such as polyethylene terephthalate (PET), and polyamides (PA) such as nylon-6 and nylon-6,6, and mixtures of two or more thereof.

The invention therefore enables use of a dual station extruder to provide multiple coated webs which are extrusion coated only on one side. In comparison to prior art methods, the method of the invention essentially increases the production rate for many single-side coated webs by a factor of two or more, and aids in achieving improved economics or lower unit production costs.

The invention further provides an apparatus for coating multiple substrate webs. In one embodiment, this web coating system includes a first web coating line having a first primary web unwind stand, a first web coating station, and a first web windup stand, all of which are substantially arranged with respect to one another so as to define a first web travel path through, which at least a portion of a first web may be passed. The coating system also includes a second web coating line having a second primary web unwind stand, a second web coating station, and a second web windup stand, all of which are substantially arranged with respect to one another so as to define a second web travel path through which at least a portion of a second web may be passed and at least a portion of which is offset from the first web travel path. In addition, the coating system includes a web turning station disposed adjacent the first and second coating lines for redirecting a coated web from the first web coating line traveling along the first web travel path into the second web coating line adjacent the second web travel path.

In certain embodiments of the web coating system, it is preferred that the first and second web travel paths are substantially parallel. Thus, for instance, the turning bars may redirect the web approximately 180 degrees from the first to the second web travel path. However, in certain other embodiments of the system, the turning bars may redirect the web approximately 90 degrees from the first to the second web travel path.

In some embodiments of the web coating system, a second web may be directed along the second web travel path while the first web is redirected to adjacent the second web travel path. In this regard, the coated web may be redirected to a path in close proximity to the second web travel path.

In another embodiment, the web coating system includes a first web coating line having a first primary web unwind stand, a first web coating station, and a first web windup stand and a second web coating line having a second primary web unwind stand, a second web coating station, and a second web windup stand. The first primary web

unwind stand, first web coating station, second web coating station and second web windup stand are all substantially arranged with respect to one another so as to define a first web travel path through which at least a portion of a web may be passed and the first web windup stand and second primary web unwind stand are offset from the first web travel path. The coating system also includes a web turning station disposed adjacent the first and second web coating lines for redirecting a first web traveling along the first web travel path onto the offset first windup stand and for redirecting a second web traveling from the offset second unwind stand adjacent the first web travel path.

In certain embodiments of the coating system, the first web windup stand may be offset from the first web travel path at a substantially perpendicular angle. In certain other embodiments, the second web primary unwind stand may be offset from the first web travel path at a substantially perpendicular angle.

The web turning station preferably comprises at least one web turning bar and more preferably comprises a plurality of turning bars and associated rollers.

It is generally preferred that the first and second coating stations are each extrusion coating systems. However, other types of coating stations may also be employed. Thus, in certain embodiments the first and second coating stations may each be selected from the group consisting of extrusion coating stations, wax coating stations, air knife coating stations, rod coating stations, gravure coating stations, and slot die coating stations.

The web coating lines may also include other devices or stations which treat or operate upon the webs. Thus, in certain embodiments, at least one of either the first or second coating lines may also include one or more of a secondary web unwind stand, a station for pre- or post-treatment of the web by corona discharge or flame treatment, a web printing station, or a web liquid primer station.

In certain embodiments, the first and second webs may be of the same width. However, the present invention also allows for the first and second webs to be of differing widths if desired.

In certain embodiments of the invention, the second coating station may also be incorporated as a part of the first coating station.

Brief Description of the Drawings

The above and other aspects and advantages of the invention will now be further described in conjunction with the accompanying drawings in which:

Fig. 1 is an elevational view of a dual extruder system for use in practicing one embodiment of the present invention;

Fig. 2 is an enlarged elevational view of two webs aligned on top of one another for processing in a dual extruder system according to one embodiment of the invention;

Figs. 3 and 4 are elevational views of the webs of Fig. 2 illustrating the application of extrusion coatings to the webs according to the invention;

Fig. 5 is an elevational view of the finished and separated webs according to one embodiment of the invention;

Fig. 6 is an elevational view illustrating in greater detail a portion of an extruder system suitable for use in practicing one embodiment of the invention;

Fig. 7 is an elevational view of a web rewinder for separating two coated webs according to a preferred embodiment of the invention;

Fig. 8 is a schematic plan view of a conventional prior art dual extruder system;

Fig. 9 is a schematic plan view of a dual extruder system according to an embodiment of the invention; and

Fig. 10 is a schematic plan view of a dual extruder system according to another embodiment of the invention.

Detailed Description of the Invention

In one embodiment, the invention involves a method for extrusion coating multiple webs on dual tandem extruder systems having multiple extrusion stations. According to one embodiment, the method includes as an initial step providing a first web and a second web wherein each of the first and second webs have a coating side and an underside. The webs are superposed one with respect to the other to form a temporary composite wherein the respective coating sides face outward and the respective undersides face one another. A first polymer coating is extruded on the coating side of the first web at a first extrusion station. A second polymer coating is extruded on the coating side of the second web at a second extrusion station. The extrusion coated first and second webs are then separated.

In the practice of the invention using, for example, a dual extruder two extrusion stations are typically arranged in series along the direction of travel of a substrate to be coated. Each extrusion station includes a hopper into which solid pellets of the polymeric coating material are feed, a heating zone wherein the polymer is melted prior to extrusion, and a slot or die through which the molten extrudate is feed and applied to the awaiting substrate web. One such dual extruder is available from Egan-Davis Standard of Somerville, New Jersey.

Referring now to the drawings, various aspects of one embodiment a method according to the invention will now be described with reference to Fig. 1 wherein a first web 10 and a second web 12 are supplied to a dual extruder, preferably from separate unwind stands 14, 16.

As used herein, the term "first web" merely refers to the web which is coated with the first coating at the first extrusion station. Likewise, the term "second web" refers to the web which is coated with the second coating at the second extrusion station. The terms "first substrate or web" and "second substrate or web" are sometimes used in the extrusion coating art to designate the web from the unwind stand nearest the ground (the first web) and the web from the unwind stand located above the first web (the second web). The nomenclature used herein may not necessarily correspond to this convention sometimes used in the art.

It is also to be noted that both unwind stands 14, 16 may be considered "primary" unwind stands as opposed to "secondary" unwind stands. Conventionally, when two webs are laminated together, a heavier, so-called "substrate" web is ordinarily referred to as the "primary" web taken from the primary unwind, and a lighter web is ordinarily called the "secondary" web taken from a secondary unwind stand, at least in conjunction with operation of the dual or multiple station extruder system. However, the first and second webs are preferably not ultimately laminated together according to the invention, at least in conjunction with operation of the dual or multiple station extruder system. Thus each web is, in essence, a primary web (according to trade nomenclature) and is taken from a primary unwind stand.

The first web 10 is provided as a substantially continuous web having two elongate, substantially parallel surfaces 20, 22 and a thickness therebetween which is

small in comparison to the length and width of the surfaces. One of the surfaces serves as a coating side 20 and the second as an underside 22. Typically, such webs 10 have a basis weight of from about 7 lbs / 3000 ft^2 to about 125 lbs / 3000 ft^2 and a thickness or caliper of from about 0.5 mil to about 10 mils. More preferably the basis weight is from about 15 lbs / 3000 ft^2 to about 90 lbs / 3000 ft^2 and the thickness ranges from about 1.0 mils to about 8.0 mils. Among preferred materials for the first web 10 are paper webs (including paperboard webs), polymer films (including oriented polymer films), metal foils, nonwoven fabrics, and two or more thereof supplied as a multi-ply web.

Like the first web 10, the second web 12 is provided as a substantially continuous web having two elongate, substantially parallel surfaces 24, 26 and a thickness therebetween which is small in comparison to the length and width of the surfaces, one of which serves as a coating side 24 and the second as an underside 26. Typically such webs 12 have a basis weight of from about 7 lbs / 3000 ft^2 to about 125 lbs / 3000 ft^2 and a thickness or caliper of from about 0.5 mil to about 10 mils. More preferably the basis weight is from about 15 lbs / 3000 ft^2 to about 90 lbs / 3000 ft^2 and the thickness ranges from about 1.0 mil to about 8.0 mils. Preferred materials for the first substrate web 12 are paper webs (including paperboard webs), polymer films (including oriented polymer films), metal foils, nonwoven fabrics, and two or more thereof supplied as a multi-ply web.

The first and second webs 10, 12 may, if desired, be substantially identical, being formed from the same materials at substantially the same thicknesses and basis weights. However, the invention is not so limited and in certain preferred embodiments of the invention, the first and second substrates 10, 12 may differ substantially in material, weight, width, and / or thickness.

The locations of the unwind stands 14, 16 relative to the extrusion stations may vary in the practice of the invention.

In one preferred embodiment, the unwind stands 14, 16 are both situated adjacent to the front of the extruder line and, as the first and second webs 10, 12 are unwound from their respective unwind stands 14, 16, the two webs are temporarily joined to one another along at least a portion of the length of the webs. This joining together is not permanent, however, in that the first web 10 is merely temporarily disposed on the second

web 12 with the respective undersides 22, 26 of the webs contacting one another as seen in Fig. 2.

Generally, the interfacial friction against any lateral sliding of the webs with respect to one another will be sufficient to keep them aligned. However, they may be temporarily adhered to one another by any of several methods. For instance, one or more edges of the two webs 10, 12 may be crimped together to hold the two webs 10, 12 together. The crimping may be accomplished at any point along the web path of wherein the webs 10, 12 are in contact with one another and prior to collection of the webs on a wind up stand using an edge crimping device 90.

Alternatively, an adhesive may be applied to one or both of the web undersides 22, 26. The adhesive may be applied by a sprayer or other coating device 72. Advantageously the coating or spray need only be applied just prior to making roll change on the windup stand.

The webs 10, 12 may also be joined by applying a static charge to one or both of the webs by a static charge device 30 prior to their contacting with each other. The static charges imparted to the webs 10, 12 may then be used to temporarily join the first web to the second web. The static charge may preferably be applied across the entire width of the web or webs.

In another preferred embodiment, the extrusion coating itself may be used to temporarily join the webs 10, 12 along one or more edges. In this embodiment, either the widths of the two webs 10, 12 differ or the webs are offset from one another somewhat so that the respective edges of the webs 10, 12 are not aligned as the webs 10, 12 pass through the extrusion stations. The extrudate then tacks down the webs 10, 12 along the unaligned edge or edges.

Any one or a combination of the above methods may be used to join the webs 10, 12 depending on the types of substrates employed.

For convenience, the temporarily joined webs are referred to collectively as the "composite web"32.

In certain other embodiments of the invention, it may be preferred that the first web 10 be coated in the first extrusion station as a single web. Thereafter the second web 12 may be laid on to the first web 10 prior to entering the second extrusion station. In this

manner, the second web 12 as well as the first web 10 may be unwound coating side up, thereby eliminating the need to invert the webs after the first extrusion station.

In another preferred embodiment, the first and second webs 10, 12 may be extrusion coated separately and then joined prior to being wound up together. Alternatively, the webs may be would up separately without ever being joined together using dual windup stands at the end of the multi-station extruder.

It is in some instances preferred, however, that the first and second webs 10, 12 be temporarily joined as shown in Fig. 2 because this facilities collecting both finished webs on a single windup stand for later separation using a rewinder. The temporary joining also allows automatic roll changes to be made at the windup stand at or near full line speed. For this purpose, the webs 10, 12 need only be joined along a portion of the webs 10, 12.

At least one layer of polymeric coating is disposed on the respective coating sides of the first and second webs 20, 24. Preferably the extruded coatings on the first and second webs 10, 12 comprise a polymer selected from the group consisting of low density polyethylene (LDPE), polyolefin plastomers (POP), polyolefin elastomers (POE), linear low density polyethylene (LLDPE), high density polyethylene (HDPE), polypropylene (PP), ethylene methyl acrylate copolymer (EMA), ethylene butyl acrylate copolymer (EnBA), ethylene vinyl acetate copolymer (EVA), ethylene acrylic acid copolymer (EAA), ethylene methyl acrylic acid copolymer (EMAA), ionomoers such as SURLYN (which is understood to be a salt of poly (ethylene-co-methacrylic acid) available from Dupont), ethylene vinyl alcohol (EVOH), polyesters such as polyethylene terephthalate (PET), polyamides such as nylon-6 and nylon-6,6, and mixtures of two or more thereof. If desired, multiple layers of the aforementioned polymers may be coextruded as well. The extruded polymer coating may contain conventional additives such as fillers, binders, extenders, and the like.

Of the aforementioned polymers for the extrusion coating, particularly preferred are low density polyethylene (LDPE), polyolefin plastomers (POP), polyolefin elastomers (POE), linear low density polyethylene (LLDPE), high density polyethylene (HDPE), and mixtures thereof.

The thickness and coating weight of the polymer layer may also vary somewhat based on the particular application. However, the polymer coatings typically have a thickness of from about 0.21 mils to about 2.0 mils and a weight of from about 3 lb/3000 ft^2 to about 29 lb/3000 ft^2.

Prior to the extrusion coating, either the first web 10 and / or the second web 12 may be surface treated, such as with a flame treatment or in an electrical corona discharge device 70, in order to oxidize the surface of the web and provide improved adhesion of the polymer coating to the web. The two webs 10, 12 are then conveyed to a first extrusion station 34 where the first polymer coating 36 is applied to the coating side of the first web 20 to provide a coated composite as illustrated in Fig. 3. Preferably, polymer is supplied in the form of pellets of the polymer which are fed into a hopper and melted and mixed with any additives to provide a fluid, relatively uniform melt-extrudible mass. The molten material is then feed through an extrusion die 38 (seen in Fig. 6), and a resulting curtain of the extruded polymeric material 40 is extruded onto the composite web 32 as it passes through a nip in the extruder formed by a backup roll 42 and chill roll 44. Contacting with the chill roll 44 cools and solidifies the extrudate on the first coating side 20.

Typically the polymer melt is extruded at a feed rate of about 500 lb/ hr to about 1000 lb / hr. while the composite web is conveyed at a speed of about 750 ft/min to about1500 feet / min. This results in a polymeric coating 36 having a thickness of about 0.5 mils. However, it will be appreciated that polymer feed rate, web width, and the web travel rate may be varied so as to provide thicker or thinner polymer coatings.

A suitable extrusion coating method, and materials for use therein, is described in commonly assigned Application Serial No. 09/978,524 entitled "Method for Extrusion Coating a Lightweight Web" having the same inventor as the present application, the disclosure of which is hereby incorporated by reference.

After the molten extrudate cools on the first web 10 to form a first coating 36 thereon, the composite web 32 is conveyed onward to a second extrusion station 50. During this movement, the first and second webs 10, 12 of the composite web 32 may be inverted or otherwise reoriented so that the second web 12 is properly aligned for coating

at the second extrusion station 50. This may be accomplished using a set of turning bars 74.

At the second extrusion station 50, the second web coating side 24 is extrusion coated with a second polymer coating 52 as shown in Fig. 4. As with the first extrusion station, the molten polymer (along with any desired additives) is then feed through a second extrusion die and a curtain of the polymer is extruded onto the composite web as it passes through a nip in the extruder formed by a backup roll and a chill roll. Contacting with the chill roll cools and solidifies the second polymer coating extrudate 52 forming a layer of polymeric coating on the composite web 32.

Typically, the second polymer melt is also extruded at a feed rate of about 500 lb/ hr to about 1000 lb / hr. while the web is conveyed at a speed of about 750 ft/min to about 1500 feet / min to provide a polymer coating 52 having a thickness of about 0.5 mils.

Finally, the two webs 10, 12, now each extrusion coated with a polymeric film, may be collected. The webs 10, 12 may be separated from one another on-line as seen in Fig. 5 and collected on separate wind up rolls directly after the second extrusion coating.

However, most extrusion coating machines currently in operation only have one windup stand. Therefore, it is preferred that the first and second webs 10, 12 be initially wound up together as a composite roll 54. As noted above, when collected as a composite roll, the webs are preferably temporarily joined together, typically along the edges of the webs 10, 12. The composite roll 54 may then be processed on a rewinder apparatus 80, shown in Fig. 7, which includes a trimmer 82 which cuts away the joined edges thereby separating the finished webs and allowing the webs 10, 12 to be individually wound up on two separate windup rolls 84, 86.

By the use of the aforegoing method it will be appreciated that a dual or tandem station extruder may be used to approach or fulfill its rated capacity while applying one-side only coatings to substrate webs. Moreover, the method allows the production speed of a dual extruder to be effectively doubled when used for one-side only coatings since two such products may now be extrusion-coated at once.

As noted, the two substrates and their respective coatings may be the same. The invention may thus be used to dramatically increase the rate of production of a single type of extrusion coated substrate. However, the substrates and / or their polymer coating may

also different. Thus, the invention provides a means to produce small batches of relatively low-volume coated substrate without halting production of much larger batches of a higher selling-volume product.

In an alternative embodiment, the present invention provides an additional method for conveying and coating at least two webs in an coating system containing multiple extrusion stations wherein the conveying and coating steps in regard to the first web are carried out independently of the conveying and coating steps in regard to the second web and during at least a portion of the time in which the conveying and coating steps are being carried out in regard to the second web.

According to this embodiment, a first web is conveyed to a first coating station in the coating system from a first unwind stand and a first polymer coating is applied on the coating side of the first web at the first coating station. The coated first web is then collected on a first windup stand. The method also includes conveying a second web to a second coating station in the coating system from a second unwind stand and applying a second polymer coating on the coating side of the second web at the second coating station and then collecting the coated second web on a second windup stand. However, in this embodiment, there is no formation of a "temporary composite", i.e., the respective webs are conveyed and coated independently of one another. Moreover, in the practice of this method, the line speed and web tension control systems of the respective stations of the coating system are selectively disconnected from one another and operated independently of one another.

In this embodiment of the invention, the first and second webs preferably each have a basis weight of from about 7 lbs/3000 ft^2 to about 250 lbs/3000 ft^2 and preferably have a caliper of from about 0.5 mils to about 20 mils.

The practice of the method is not limited to the use of extrusion coatings and extrusion coating stations. Rather the method is generally applicable to numerous coating technologies including coating technologies the group consisting of extrusion coating stations, wax coating stations, air knife coating stations, rod coating stations, gravure coating stations, and slot die coating stations. (As used herein, a coating station is a device which applies coating to a substrate for any purpose such as, for example, and not by way of limitation, a functional coating to a substrate for the purpose of creating a

barrier on the substrate, to form a sealant layer upon the substrate, or to join the substrate to another material.) However, it is generally preferred that both the first and second coatings stations be extrusion coating stations.

Particularly preferred polymeric extrusion coatings include polymers selected from the group consisting of low density polyethylene (LDPE), polyolefin plastomers (POP), polyolefin elastomers (POE), linear low density polyethylene (LLDPE), high density polyethylene (HDPE), polypropylene (PP), ethylene methyl acrylate copolymer (EMA), ethylene butyl acrylate copolymer (EnBA), ethylene vinyl acetate copolymer (EVA), ethylene acrylic acid copolymer (EAA), ethylene methyl acrylic acid copolymer (EMAA), ionomoers such as SURLYN (which is understood to be a salt of poly (ethylene-co-methacrylic acid) available from Dupont), ethylene vinyl alcohol (EVOH), polyesters such as polyethylene terephthalate (PET), polyamides such as nylon-6 and nylon-6,6, and mixtures of two or more thereof. The first and second webs may be coated with the same or with differing coating materials.

Suitable substrate materials for either or both of the first and second webs include paper webs, polymer films, nonwoven fabrics, metal foils, and multi-ply webs comprising two or more thereof. As used herein, the terminology "paper web" (singular or plural) includes also the so-called "paperboard" webs, which are, generally speaking, paper-based webs having relatively higher basis weights. The first and second webs may comprise the same or different substrate materials, and each web may also be a composite itself made up of different materials. Likewise, the first and second webs may be of the same or of different web widths.

The independent processing of the first and second webs may be achieved using an improved multi-station coating system. The coating system is described herein with respect to a two-station extrusion coating system; however, the invention may also be practiced with different types of coating station technologies and with more than two coating stations incorporated within the coating system. The improvements to the dual-station extrusion coating system are illustrated by reference to Figs. 8 - 10.

Fig. 8 illustrates, in schematic fashion and as viewed from above, a conventional arrangement for a two-station extrusion coating line. The system includes a primary unwind stand 114 from which a first substrate web 110 is unwound. The web 110 may

then be subjected to a pre-treatment process, such as a flame or corona discharge treatment, at a pretreatment station 160. The web 110 then travels to a first extrusion coating station 134 where a polymeric coating is applied to one side of the web 110. The extrusion coating system may also include a post-treatment station 162 for further treatment of the coated web by flame or corona discharge, a printing or liquid priming station 164, and a secondary unwind stand 166 for providing a secondary web. A web turning station 174, such as a set of web-turning bars and associated idler rollers, may also be included for inverting the horizontal surfaces of the web prior to further processing at the second extrusion coating station 150.

The second extrusion coating station 150 applies a second coating layer either to the first web 110 or to a secondary web now associated with the web. The web or webs may also be further processed at pre- or post-treatment stations 168, 170 adjacent to the second extrusion coating station 150. Finally the coated web is collected on a windup stand 184.

Notably, all of the web coating and associated processing equipment in Fig. 8 are arranged "in-line" with one another so as to define a single web travel path or direction.

In contrast to Fig. 8, Fig. 9 illustrates a two-station extrusion coating line according to another embodiment of the present invention. In this coating system, an additional, selectively operable web-turning station 276 is placed between the two extrusion coating stations 234, 250. The web-turning station may include at least one, and preferably a plurality of, web-turning bars along with any associated idler rollers. As those of skill in the art will appreciate, a web-turning "bar" is a device, such as a cylindrical or conical roller, over which a moving web may be passed in order to change the direction of travel of the moving web.

In addition, the modified system also includes an extra web unwind stand 216 and an extra windup stand 286. Both the unwind and windup stands 216, 286 are located adjacent the selectively operable web-turning station 276 and are offset from the web travel path defined by the remaining units of the system, that is, the stands 216, 286 are not aligned with the aforementioned web travel path. The stands 216, 286 are preferably at a substantially perpendicular, or 90 degree, angle. This offset is preferably

is a horizontal direction; however, unwind stand 216 and windup stand 286 may also be offset vertically, that is above or below the coating lines.

By selective use of the web-turning station 276, the two-station extrusion coating system may be operated in one of two entirely different modes. In the first mode, the web-turning station 276 are deactivated and un-utilized leaving the windup stand 286 and unwind stand 216 by-passed from the system. In this mode, the extrusion system functions much like a conventional two station extrusion coating system and may be used to apply two extrusion coatings to a single web.

The web is unwound from a first unwind stand 214 and conveyed along a single web travel path along which it is coated at a first extrusion station 234 and a second extrusion station 250 and collected at a final windup stand 284. Optionally, the web may also be oxidatively treated by flame or corona discharge at one or more pre-treatment stations 260, 268 or post-treatment stations 262, 270. The web may also pass through a printing station 264 or a further web turning station 274 for inverting the web. A secondary web may also be unwound from a secondary unwind stand 266 and applied to the web as well.

In the second mode of operation, the selective web-turning station 276 is utilized along with the extra unwind and windup stands 216, 284 to cause two webs 210, 212 to be extrusion coated simultaneously, yet independently, of each other. In this mode, the system provides two extrusion coating lines and the line speed and web tension of each coating line is controlled independently of the other. The first web coating line includes the first primary web unwind stand 214 with the first web 210, the first web extrusion coating station 234, and the offset first web windup stand 286. The second web coating line includes the offset second primary web unwind stand 216 with the second web 212, the second web extrusion coating station 250, and the second web windup stand 284. The coating lines may also optionally include pre-treatment stations 260, 268, post-treatment stations 262, 270, and liquid priming or printing station 264.

In this mode, the web turning station 276 disposed adjacent to the first and second web coating lines is used to redirect the first web 210 exiting the first coating station 234 along the main web travel path onto the offset first windup stand 286 and to redirect a second web 212 from the offset second unwind stand 216 into the second coating station

250 along the main web travel path. Thus, two webs may be processed simultaneously yet completely independently of one another. Moreover, the webs may be of the same or differing materials or widths, and may be coated with the same or differing coatings.

In Fig. 10, a further modification of the two-station extrusion coating system is shown wherein the second extrusion station 350 has been relocated and is no longer "in-line" with the first extrusion station 334. Rather the two extrusion coating stations and their associated unwind and windup stands are set apart so as to define a first web travel path and a second web travel path. The second web travel path is offset from the first web travel path in the sense that the second web travel path, or at least a portion thereof, does not pass through the first web travel path, or at least a portion thereof. By way of example and not by way of limitation, the second web travel path is offset from the first web travel path by reason of the fact that the second web travel path is defined along the second web coating line and the first web travel path is defined along the first webcoating line and the first and second web coating lines are physically separated from one another.

In Fig. 10, the two coating lines, together with their associated web handling and processing equipment, described in further detail below, form a generally "H-shaped" configuration as viewed from above. A particular advantage of this configuration is that it allows for the more efficient and compact utilization of coating lines having a relatively large number of auxiliary devices such as flame and corona discharge treaters, printers, primers and the like. However, it is also contemplated that the two coating lines could be incorporated into a single device while still having the first and second web travel paths offset from one another.

As with the coating system shown in Fig. 9, the coating system in Fig. 10 also provides two modes of operation. In a first mode of operation, the two extrusion coating stations 334, 350 operate independently of one another to provide two single station extrusion coating lines. In the first extrusion coating line, a first web 310 travels from a first primary unwind stand 314 along a first web travel path and is extrusion coated at a first extrusion coating station 334 and then collected on a first windup stand 386.

In the second extrusion coating line, a second web 312 may simultaneously travel along a second, generally parallel, web travel path, from a second primary unwind stand

316, to a second extrusion coating station 350 and then be collected on a second windup stand 384.

Either or both coating lines may also include a flame or corona discharge pre-treatment station 360, 368 or post-treatment station 362, 370 a printing or priming unit 364a, b, c, d and a secondary web unwind stand 366.

In a second mode of operation, a web-turning station are utilized to bypass unwind stand 316 and windup stand 386 and redirect a first web 310 exiting the first coating line along the first web travel path onto the second coating line adjacent the second web travel path. Thus, a web 310 may be unwound from the first unwind stand 314, coated in the first extrusion station 334, redirected by the turning bars 376, coated again in the second extrusion station 350 and then collected on a windup stand 384. In this manner, both the first and second extrusion coating stations 334, 350 may be used to apply multiple extrusion coatings to a single web 310.

In this second mode of operation, the first web 310 need only be adjacent the second web travel path. Thus, while the first web 310 may be redirected to substantially occupy the second web travel path, the first web 310 may alternatively be redirected in close proximity to the second web travel path by not actually occupying the second web travel path. Thus, for example, a second web 312 could also be provided which passes through the second coating line simultaneously with the first web 310 so as to provide at least some for of support for the web in the manner described in commonly assigned application Serial No. 09/978,524 entitled "Method for Extrusion Coating a Lightweight Web", the contents of which are incorporated herein by reference. The second web 312 would occupy the actual second web travel path while the first web 310 is redirected in close proximity to the second web travel path. The two webs 310, 312 could then be wound up together or separately.

The following nonlimiting example illustrates various additional aspects of the invention.

Example 1

Two webs of kraft paper, each having a basis weight of about 31.5 lbs / 3000 ft^2 and a caliper of about 2.5 mils and having widths of about 31.75 inches (the first web) and 34 inches (the second web) respectively were unwound from separate rolls and

conveyed to an extrusion coating system by a series of rollers and idlers. The two webs so combined were passed through a first extrusion station.

In the first extrusion, a supply of low density polyethylene, EASTACOAT 6838-850P available from Eastman Chemical Co. of Longview, TX was heated to a temperature of about 610 ° F to provide a supply of molten extrudate. The molten extrudate was then feed through an extrusion die at a feed rate of about 250 lb/hr to coat the exposed side of the first paperweb as it moved through the extrusion station. The extrudate was cooled by contacting with a chill roll forming a polymer coating over the kraft paper of the first web. The polymer coating weight was about 8 lbs /ream.

Because of the slightly narrower width of the first web, the extrudate coating temporarily joined the two webs together.

A second extrusion coating was then applied to the second substrate web. A second supply of low density polyethylene was heated to a temperature of about 610 ° F to provide a supply of molten extrudate. The molten extrudate was then feed through an extrusion die at a feed rate of about 250 lb/hr to coat the second paperweb as it moved through the second extrusion station. The extrudate was cooled by contacting with a chill roll to form a polymer coating over kraft paper of the first web. The polymer coating weight formed on the second web was also about 8 lbs /ream.

The embodiments described above are intended to be exemplary only. It will be appreciated by those of skill in the art that the invention may be practiced using a variety of extrusion station configurations wherein the number and location of the unwind and windup stations may be varied in relation to the extrusion coating stations, and that numerous other modifications, variations and substitutions may exist within the spirit and scope of the appended claims.